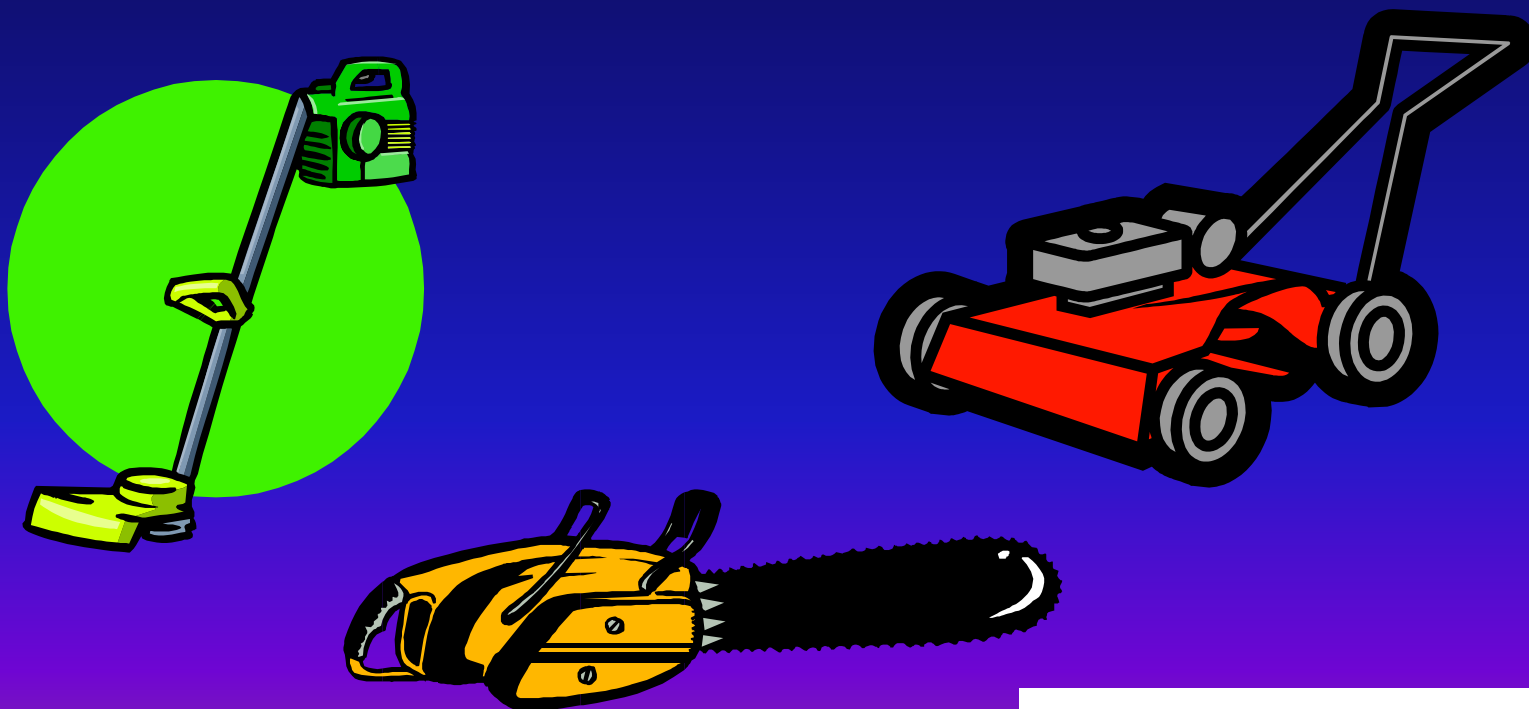


Control Measure to Reduce Emissions from Small Off-Road Engines (SORE)

Mobile Source Control Division
Monitoring and Laboratory Division
California Air Resources Board

September 25, 2003
Board Hearing



California Environmental Protection Agency



Air Resources Board

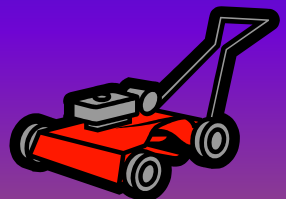
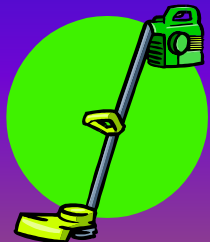
Outline

- Background
- Proposed Exhaust Emission Standards
- Proposed Evaporative Emission Standards
- Environmental Benefits
- Economic Impacts
- Conclusion

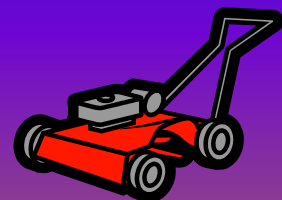
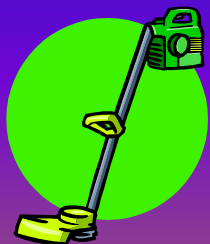
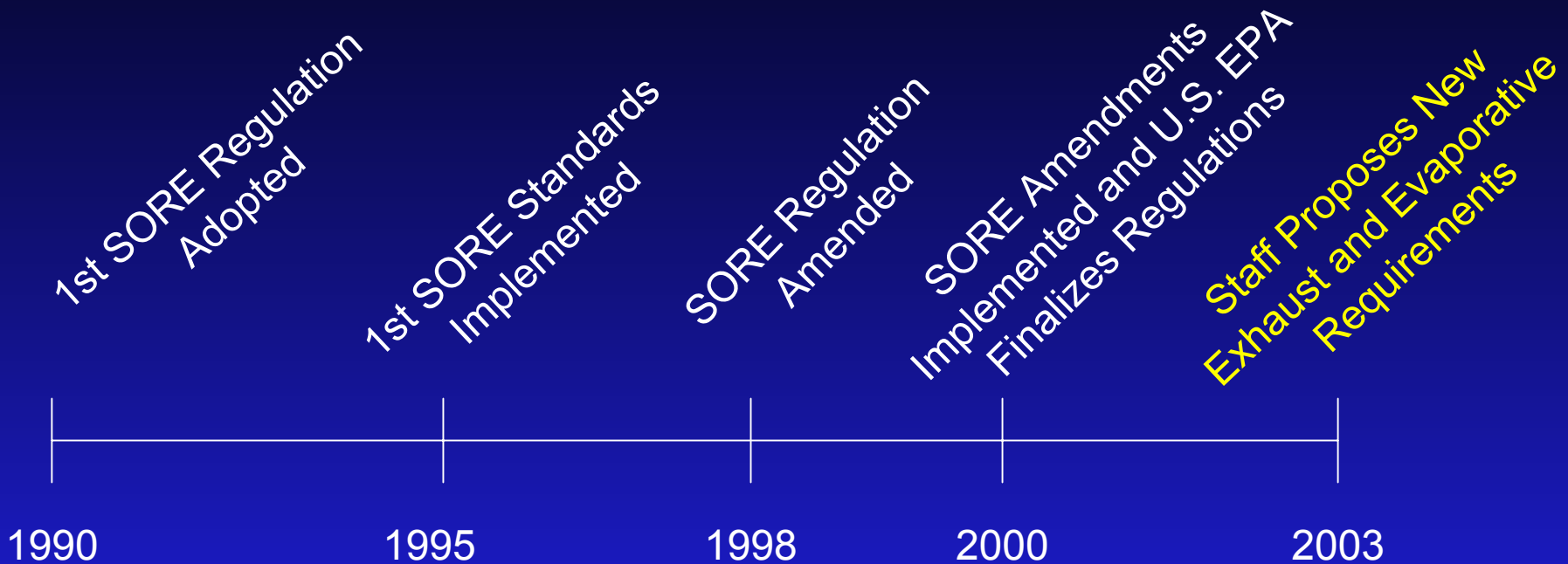
Small Off-Road Engines and Equipment (SORE)

- Engines ≤ 19 kW
- Two and four-stroke engines
- Lawn and garden and small industrial equipment
- Preempt: farm and construction equipment < 175 hp

Examples of SORE Equipment



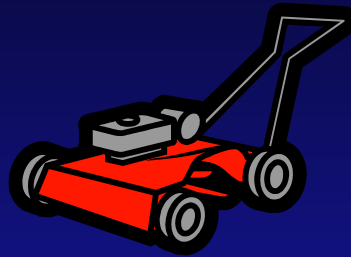
History



Need for Regulation

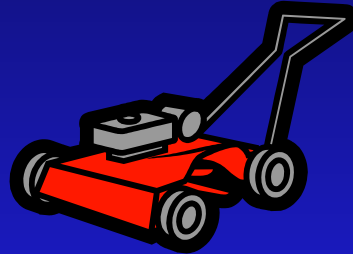
Exhaust and Evaporative Emissions Statewide
HC+NOx Baseline - Nonpreempt

2020



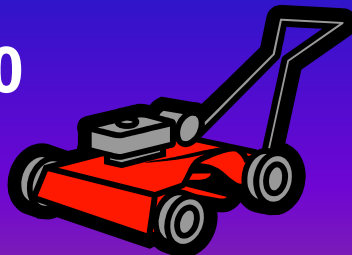
121 tpd

2010

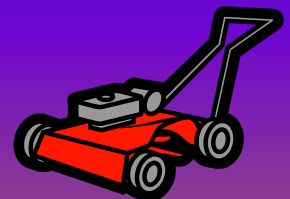
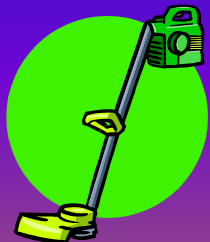


111 tpd

2000

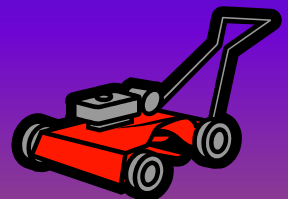
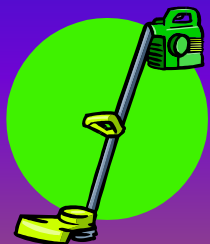


152 tpd



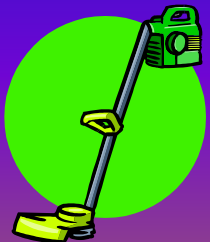
New SIP Commitments

- Includes two SORE measures
 - SMALL OFF-RD-1
 - SMALL OFF-RD-2
- Staff's proposal designed to accomplish goals of both measures



Proposed 2005 Handheld Standards Tier 3

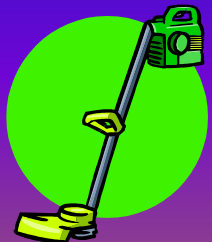
- Align with most stringent U.S. EPA HC+NO_x standard for engines < 50 cc
 - 50 g/kW-hr
 - 30% reduction from current standard



Handheld - Exhaust

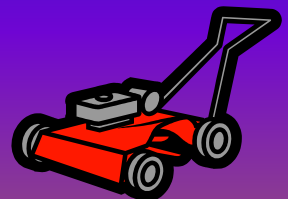
Tier 3 Levels Already Met By Some

- Currently 25 CA engine families certified to levels below proposed Tier 3
- Includes all types of handheld equipment
- Technologies
 - Four-stroke
 - Two-stroke with a catalyst
 - Stratified scavenging
 - Two-stroke/four-stroke hybrid
 - Electric equipment



Proposed 2007/8 Nonhandheld Standards Tier 3

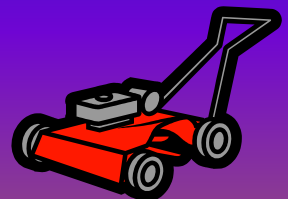
- Staff's Original Proposal
 - >80 - <225cc: 8.0 g/kW-hr, 2007+ MY
 - 225cc and above: 6.0 g/kW-hr, 2008+ MY
- Alternative Proposal
 - >80 - <225cc: 10.0 g/kW-hr, 2007+ MY
 - 225cc and above: 8.0 g/kW-hr, 2008+ MY
- Standards based on the use of a catalytic converter



Catalyst Test Program to Show Technical Feasibility

- Three-way catalyst
- Secondary air injection
- Some enleanment of A/F

Engine	Power (kW)	Application
B&S #1	4.8	WBM
B&S#2	4.8	WBM
Tecumseh	4.8	WBM
Honda #1	4.1	WBM
Kawasaki	14.2	Riding Mower
Honda #2	8.2	Generator



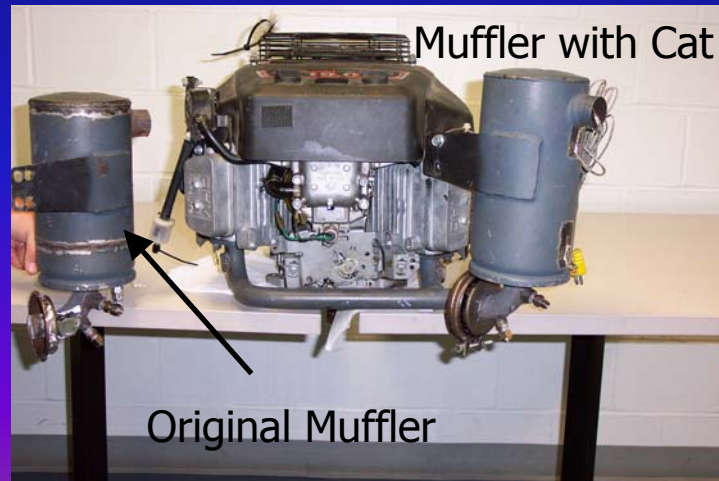
Catalyst Pictures



B&S #2

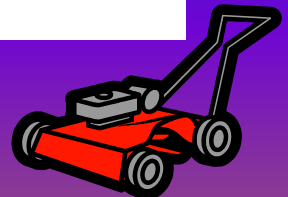
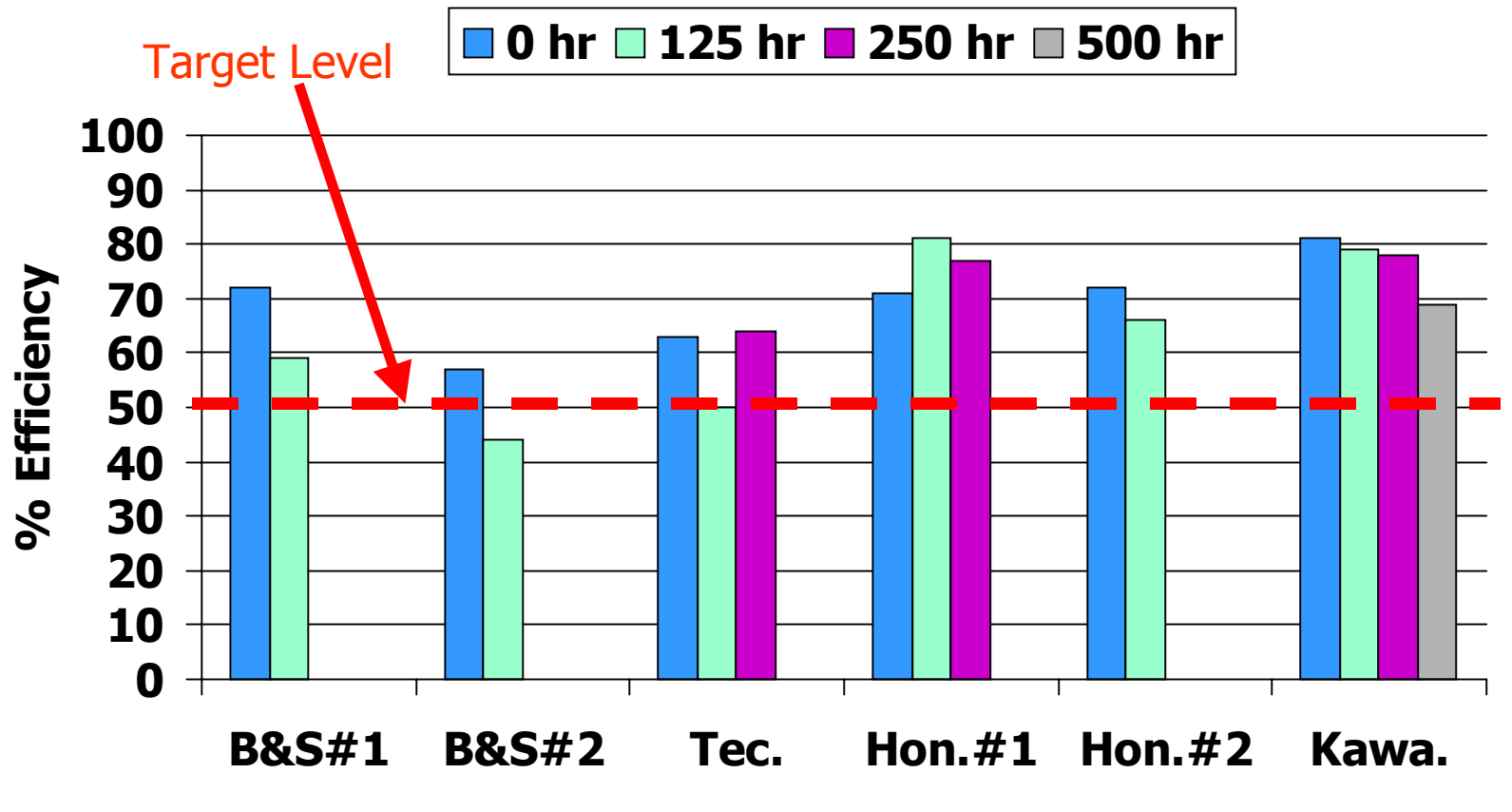


Honda #2



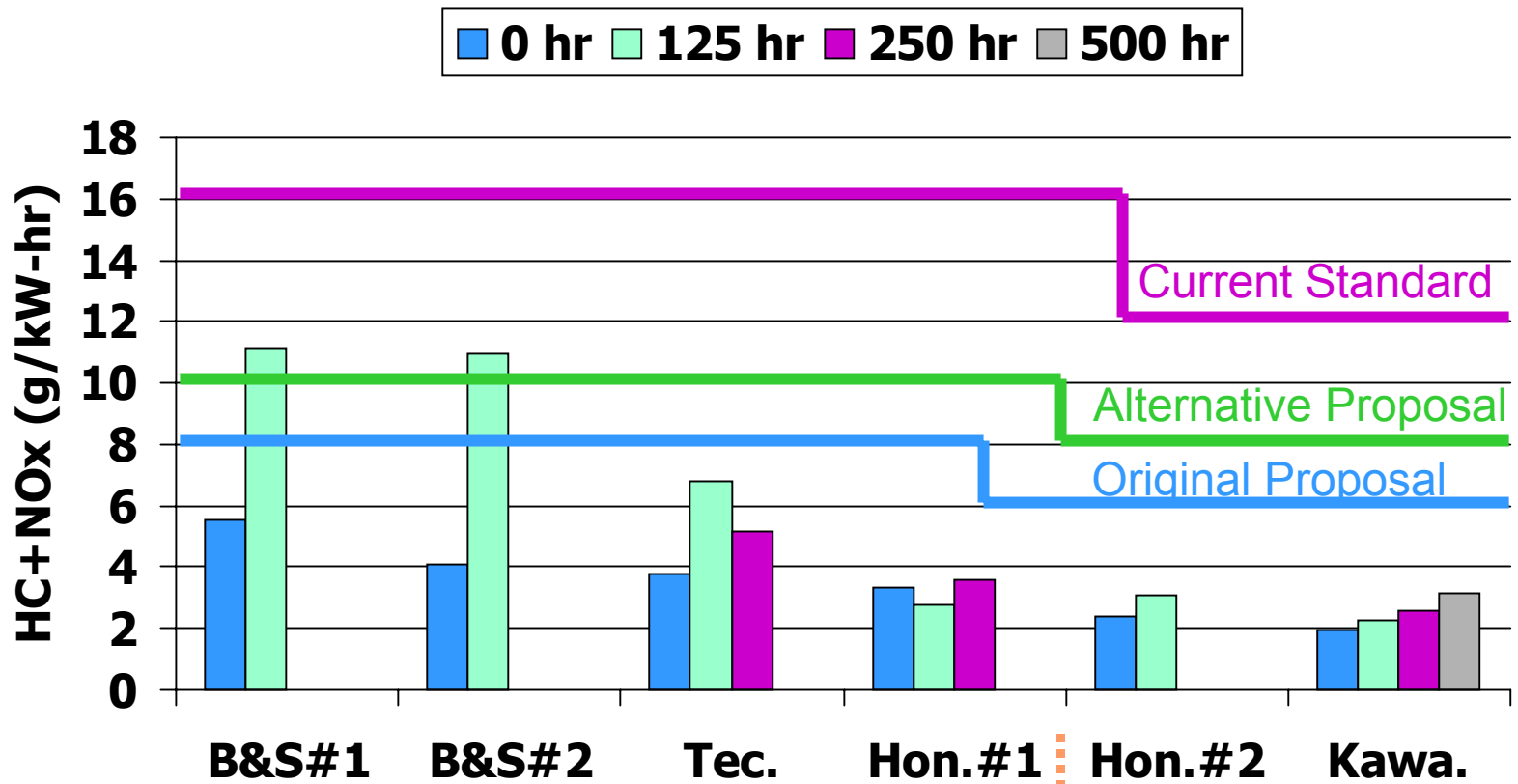
Kawasaki

Catalyst Efficiency



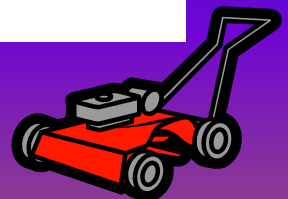
Exhaust Levels Achieved

Developed Engine Emissions

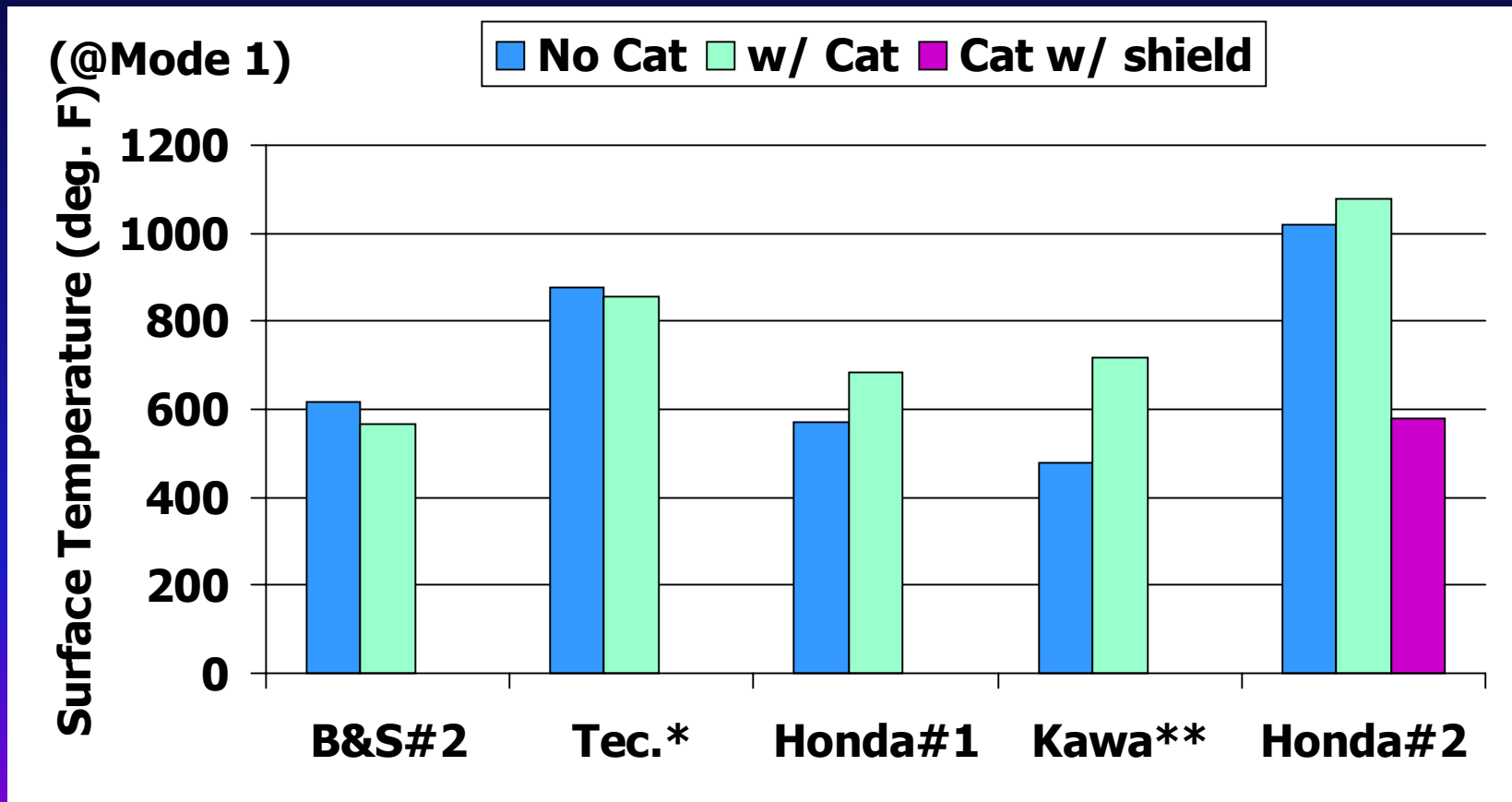


>80 cc - <225cc

≥225cc

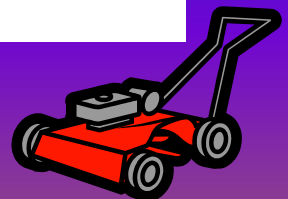


Muffler Surface Temperatures



* At 250 hours

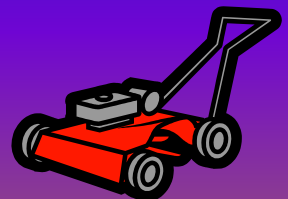
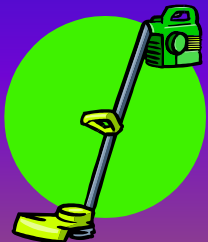
** At 125 hours



Summary of Proposed Tier 3 Standards

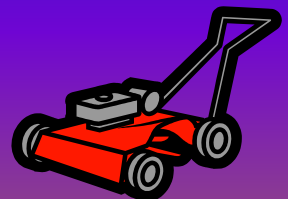
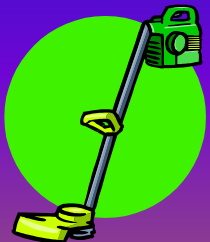
Size (cc)	MY	HC+NOx Standard (g/kW-hr)
< 50	2005+	50
<u>></u> 50 - <u><</u> 80	2005+	72
>80 - <225	2007+	8/10*
<u>></u> 225	2008+	6/8*

* Alternative Standards



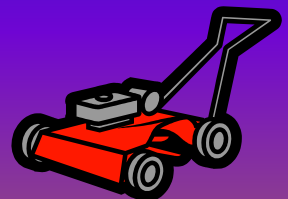
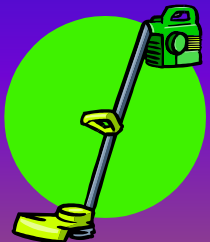
"Blue Sky" Engine Standards

- Voluntary
- HC+NOx levels 50% of Tier 3 standard
- Provides opportunity for clean label and incentives
- Includes zero-emission engine eligibility



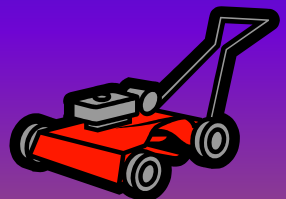
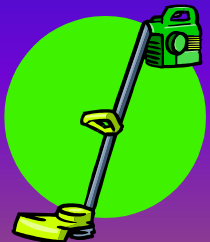
Additional Changes to Exhaust Regulations

- Alignment with U.S. EPA
 - < 25 hp vs. ≤ 19 kW
 - 1000 hour durability option
 - Test procedures
- Handheld limit raised to 80cc



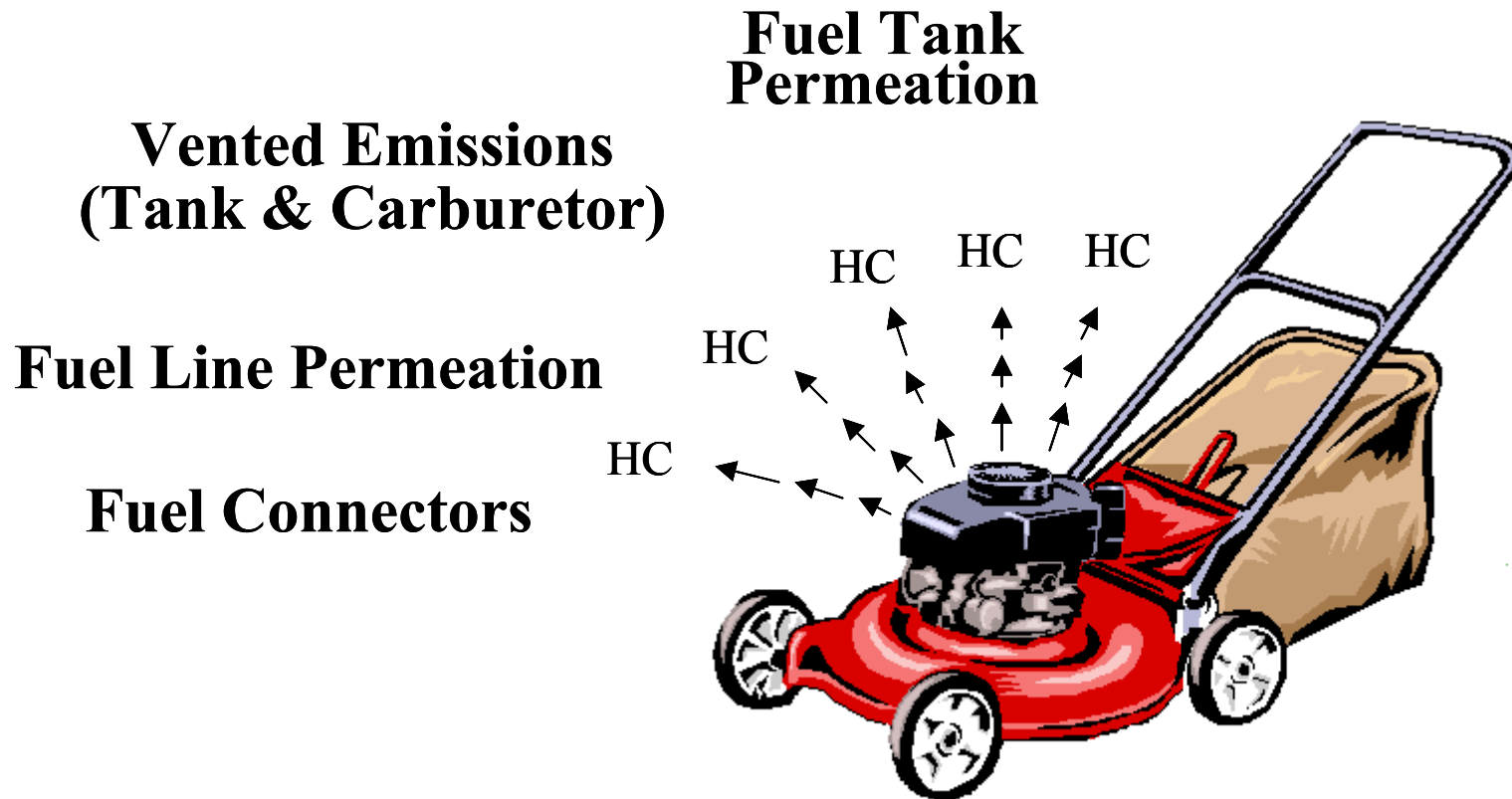
Additional Changes to Exhaust Regulations

- Warranty Defects Reporting
 - Voluntary/Ordered Recall
 - Included in Exhaust and Evaporative Program
- Additional text to clarify use of cooling fans during testing



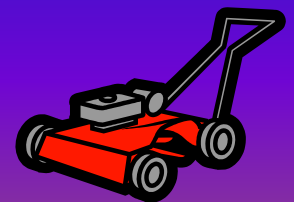
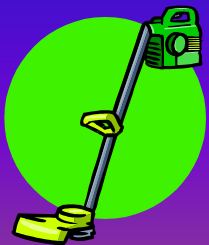


Sources of SORE Evaporative Emissions



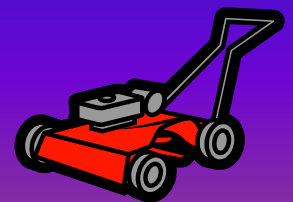
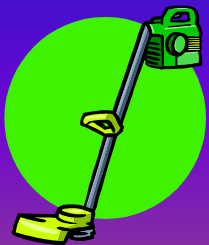
Overview

- Evaporative Emission Control Elements
- Control Technology and Test Data
- Industry Issues
- Nonhandheld Alternatives
- Comparison of Alternatives
- Overall Cost Effectiveness
- Conclusions



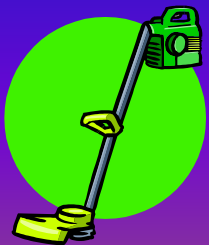
Evaporative Emission Control Elements

- Handheld standards
- Nonhandheld standards
- Certification



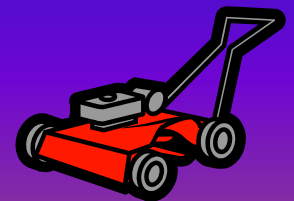
Handheld Standard

SORE Equipment Category	Effective Date Model Year	Permeation Standard Grams ROG/m ² /day	Diurnal Standard Grams HC/day
≤ 80 cc	2007	2.0	None



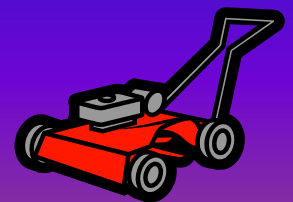
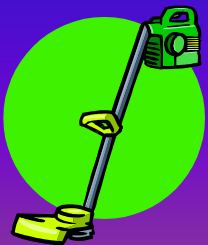
Nonhandheld Standards

SORE Equipment Category	Effective Date Model Year	Permeation Standard Grams ROG/m²/day	Diurnal Standard Grams HC/day
Walk-Behind Mowers > 80 cc - < 225 cc	2007	None	1.0
> 80 cc - < 225 cc Excluding Walk-Behind Mowers	2007	None	0.21 * Tank Volume (gal.) + 0.95
≥ 225 cc	2008	None	2.0



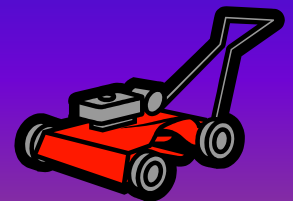
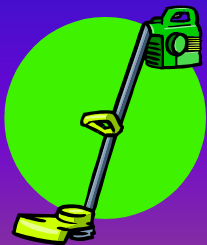
Certification

- Requires certification of evaporative families
- Handheld tanks
 - Tested per TP-901
 - Certified per CP-901
- Nonhandheld equipment
 - Tested per TP-902
 - Certified per CP-902



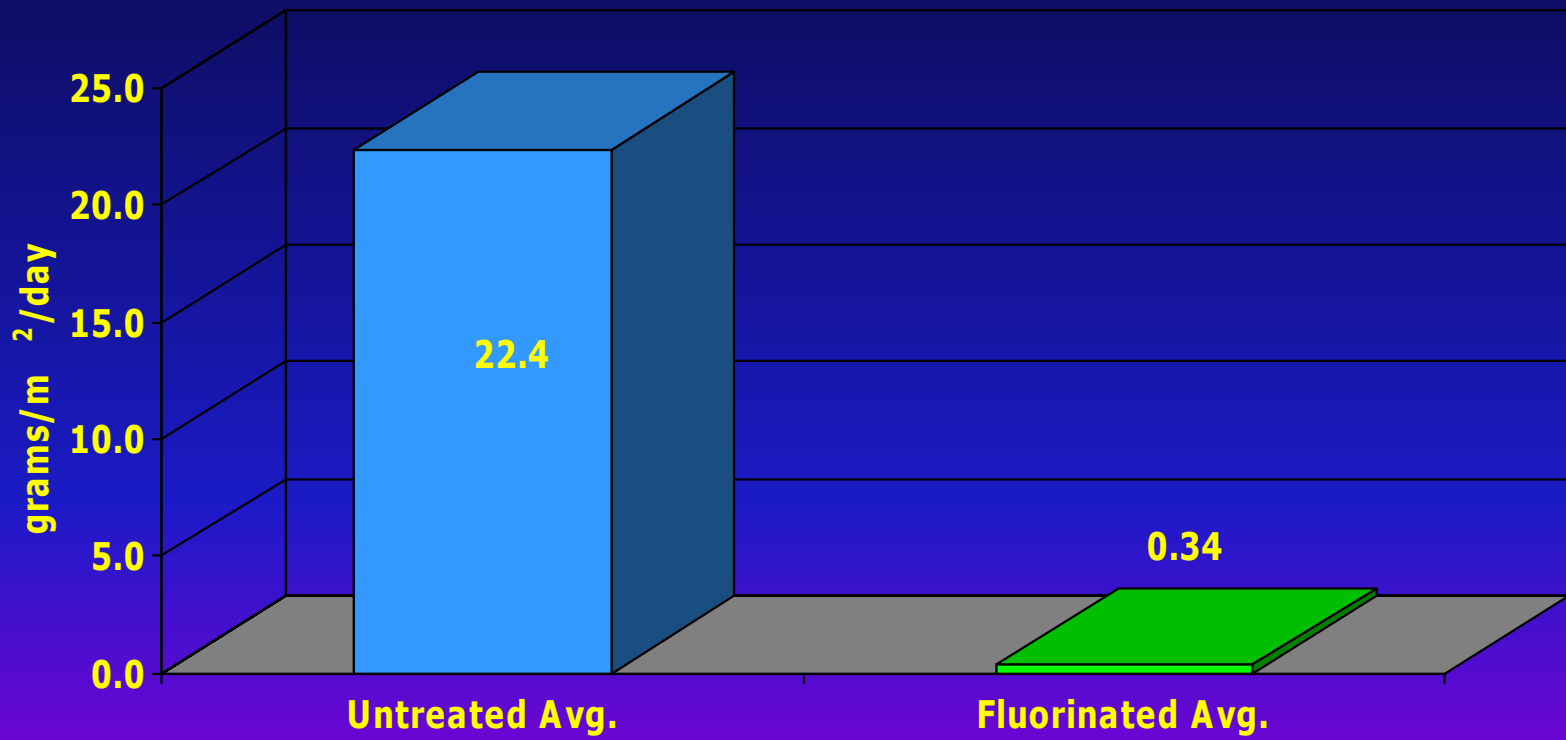
Permeation Control Technologies

- Tanks
 - Metal and coextruded tanks, nylon tanks, and barrier treatments
- Connectors, Gaskets, and Hoses
 - Thermoplastic materials, Viton®, and Teflon®



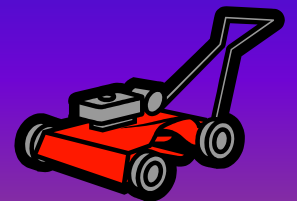
ARB Permeation Test Data

Untreated HDPE Tanks vs. Optimized Fluorinated Tanks



Diurnal Emission Control Technologies

- Sealed systems
- Carbon canister systems
- Hybrid sealed systems



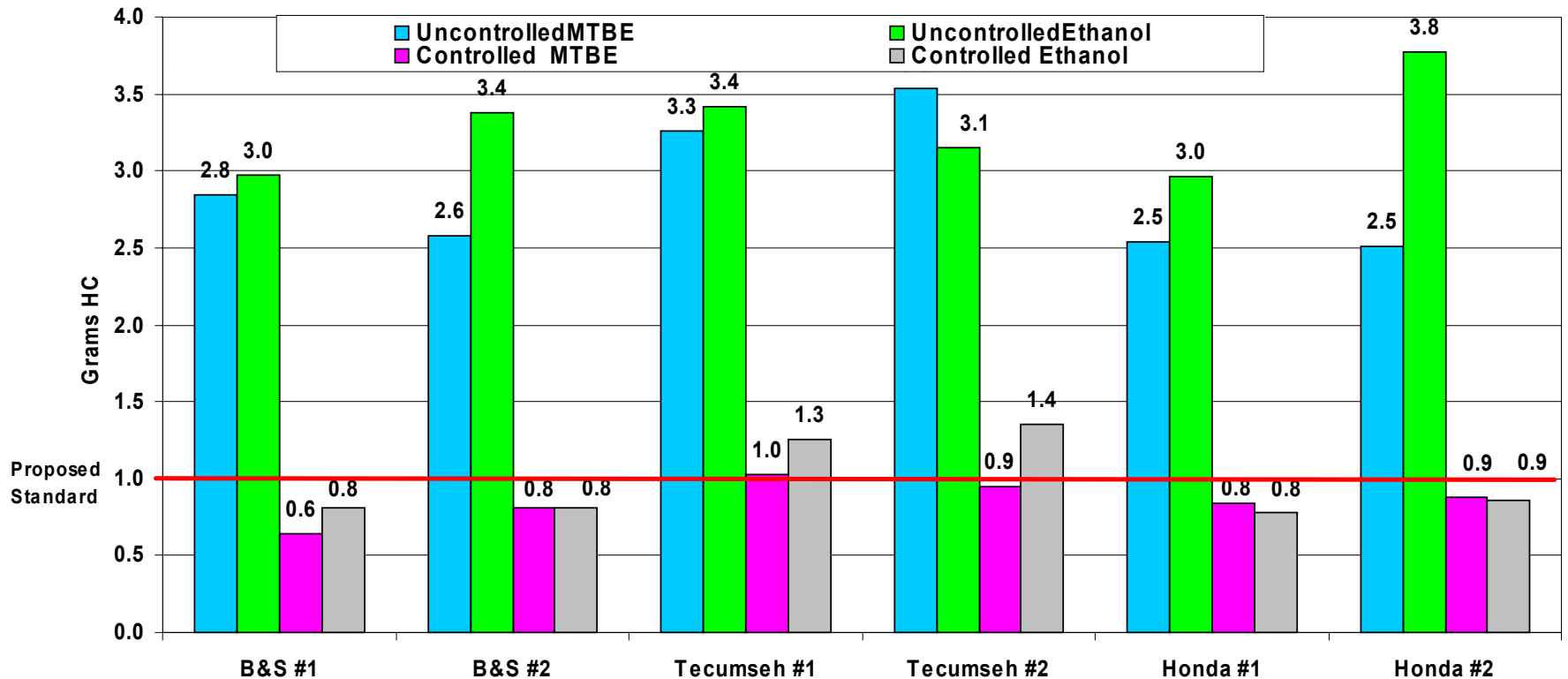
Diurnal Emission Control Technologies

ARB Feasibility Testing

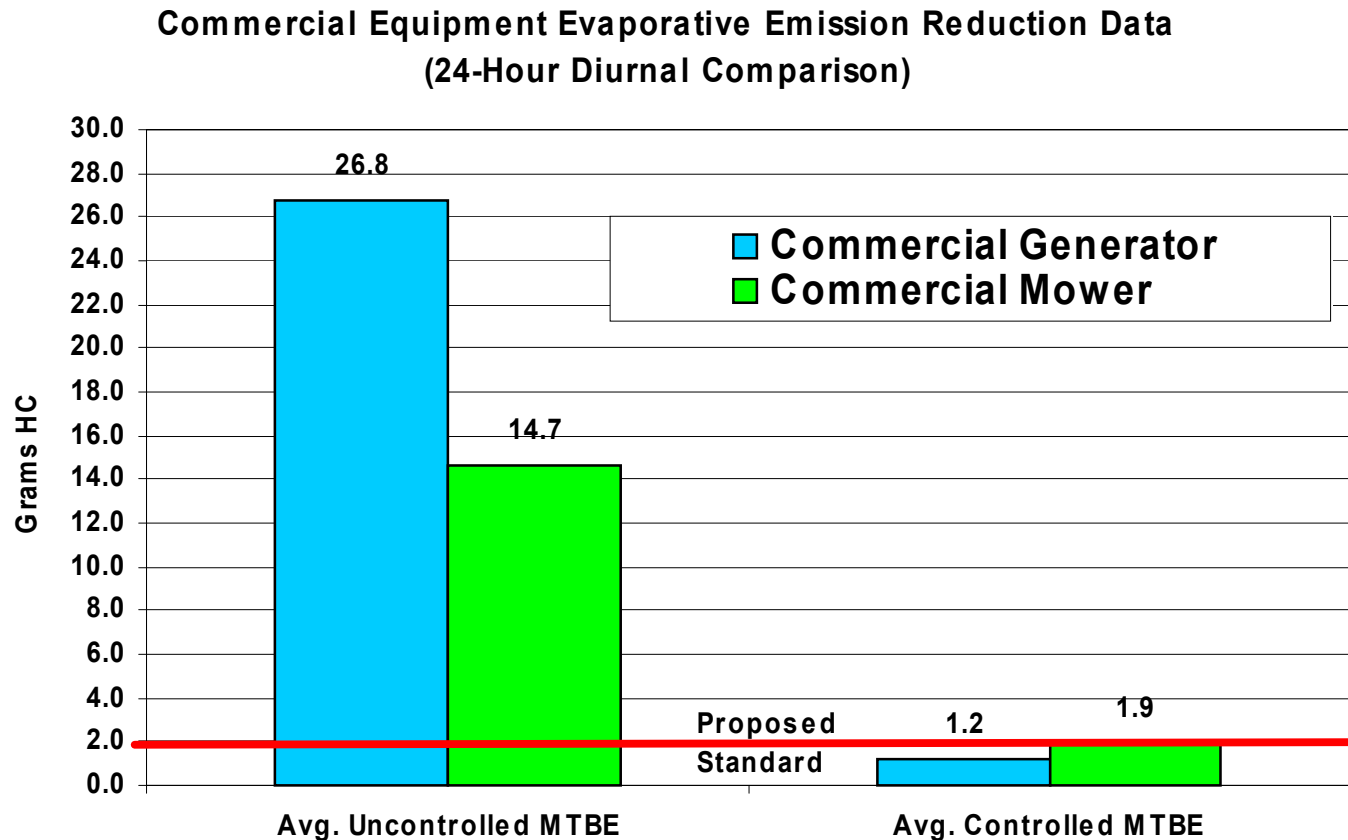
- ARB tested prototype equipment
- Six mowers configured with:
 - sealed systems,
 - fluorinated HDPE tanks
 - low permeation fuel lines
- A generator and commercial mower configured with:
 - carbon canisters
 - metal tanks
 - low permeation fuel lines

ARB Test Results for Sealed Systems

Lawn Mower Evaporative Emission Reduction Data
(24-Hour Diurnal Fuel Comparison)

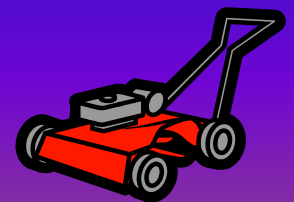
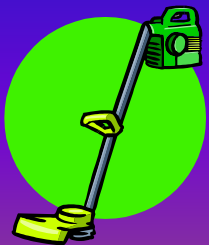


ARB Test Results for Canister Systems



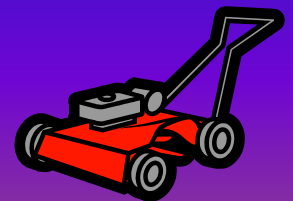
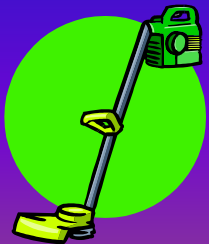
Additional Changes to the Evaporative Proposal

- Adjust canister working capacity in TP-902
- Require small volume manufacturers to submit a letter of conformance



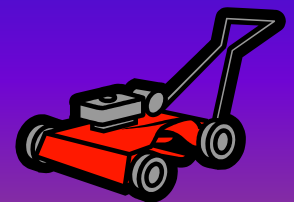
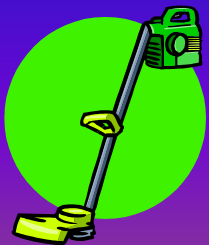
Industry Issues

- Standards too stringent
 - Exhaust
 - Evap.
- Proposal lacks flexibility
- Costs too high



Alternatives Suggested by Industry

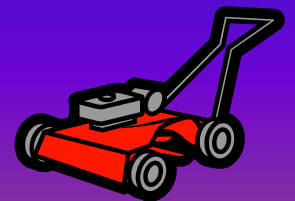
- Alternatives presented by Briggs & Stratton, EMA/OPEI, and Honda
- Staff evaluated alternatives
- Alternatives 1 and 2 developed from industry proposals



Nonhandheld Alternatives

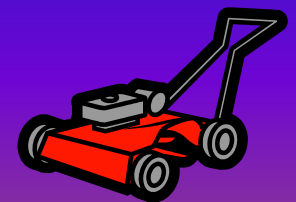
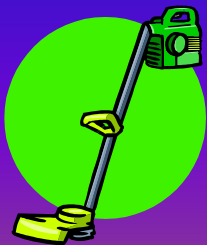
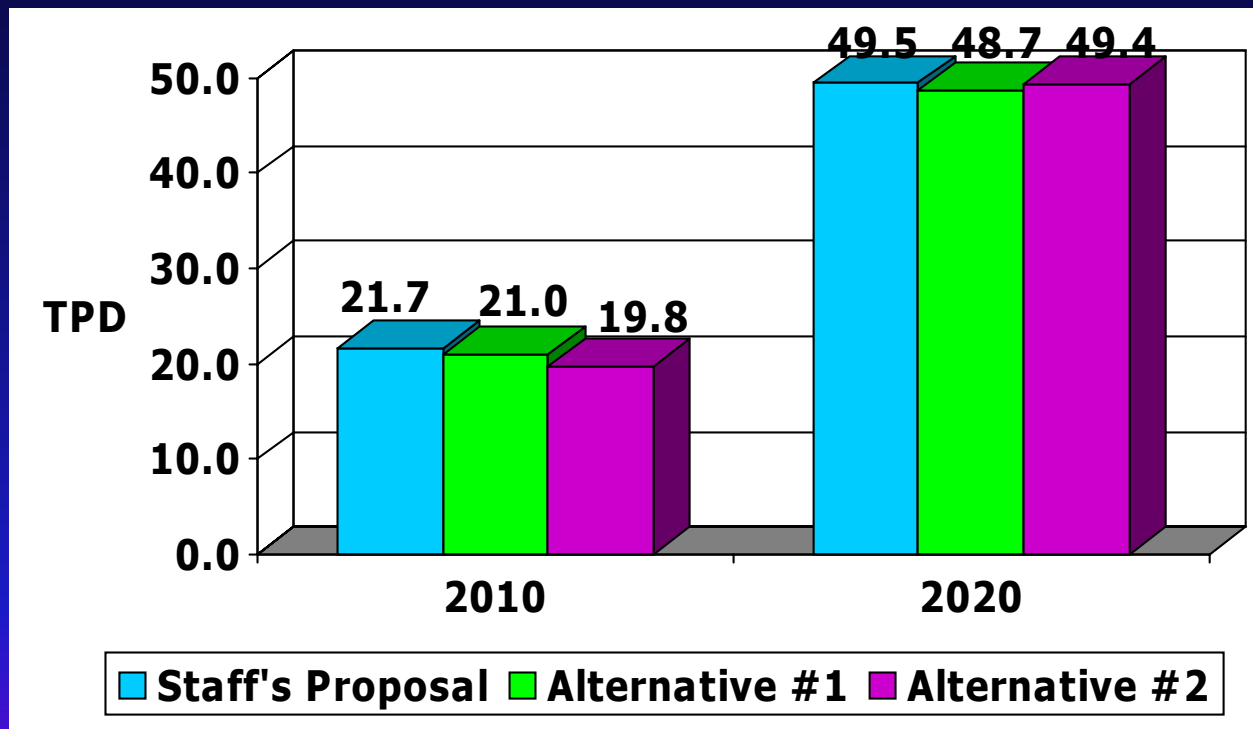
Alternative 1 and 2 would:

- Provide nearly same emission reductions
 - Greater evaporative emission reductions
 - Less exhaust emission reductions
- Provide flexibility for compliance
- Reduce costs
- Meet SIP commitments



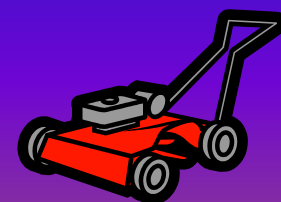
Overall Emission Reductions

Statewide Comparison of the Alternatives
(Annual Average Tons Per Day for Nonpreempt Equipment)



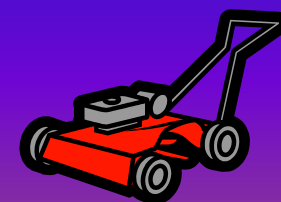
1st Alternative - Major Elements

- Achieves additional evaporative emission reductions (running loss)
- Requires testing of complete engines
- Implements low permeation hoses one year early
- Allows fleet averaging



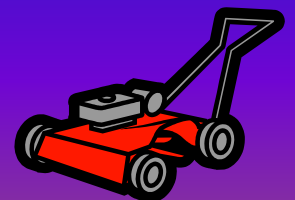
1st Alternative - Nonhandheld Standards

Effective Date Model Year	Engine Displacement	Fuel Hose Permeation Standard Grams ROG/m2/day	Diurnal Standard Grams HC/day
2006	> 80 cc	15	None
2007 and 2008	> 80 cc - < 225 cc	15	1.2 + 0.21*tank vol. (gal)
2009 WBM's	> 80 cc - < 225 cc	15	1.0
2009 Non- WBM's	> 80 cc - < 225 cc	15	0.95 + 0.21* tank vol. (gal)
2008	≥ 225 cc	15	1.2 + 0.21* tank vol. (gal)



2nd Alternative - Major Elements

- Achieves additional evaporative emission reductions (running loss)
- Requires testing of Class I walk-behind mowers (WBM)s
- Implements low permeation fuel hoses two years early
- Reduces compliance testing (design standards)



2nd Alternative - Nonhandheld Standards

Class I Engines, > 80 cc - < 225 cc

Walk-Behind Mowers

Effective Date Model Year	Fuel Hose Permeation Standard Grams ROG/m2/day	Diurnal Standard Grams HC/day
2005	15	None
2007 thru 2011	15	1.3
2012	15	1.0

Non Walk-Behind Mowers

Effective Date Model Year	Fuel Hose Permeation Standard Grams ROG/m2/day	Fuel Tank Permeation Standard Grams ROG/m2/day	Carbon Canister or Equivalent Butane Working Capacity Grams HC/Liter Tank Vol.
2005	15	None	None
2007 thru 2011	15	2.5	Per TP-902
2012	15	1.0	Per TP-902

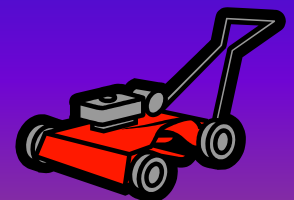
2nd Alternative - Nonhandheld Standards

Class II Engines, ≥ 225 cc

Effective Date Model Year	Fuel Hose Permeation Standard Grams ROG/m ² /day	Fuel Tank Permeation Standard Grams ROG/m ² /day	Carbon Canister or Equivalent Butane Working Capacity Grams HC/Liter Tank Vol.
2005	15	None	None
2008 ¹	15	3.0	Per TP-902
2010 ²	15	None	Per TP-902
2013 ¹	15	1.0	Per TP-902

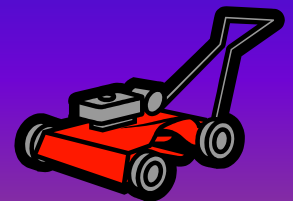
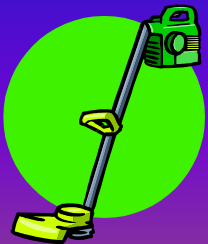
¹ First year of implementation 90% of production volume must be compliant increasing to 100% the following year.

² Applies to small volume manufacturers.



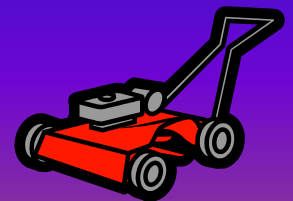
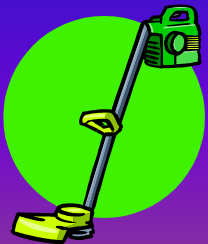
Overall Cost Effectiveness

- Handheld Equipment - \$1.71 to \$6.21 per pound of HC reduced
- Nonhandheld Equipment – \$0.20 - \$4.30 per pound of HC+NO_x

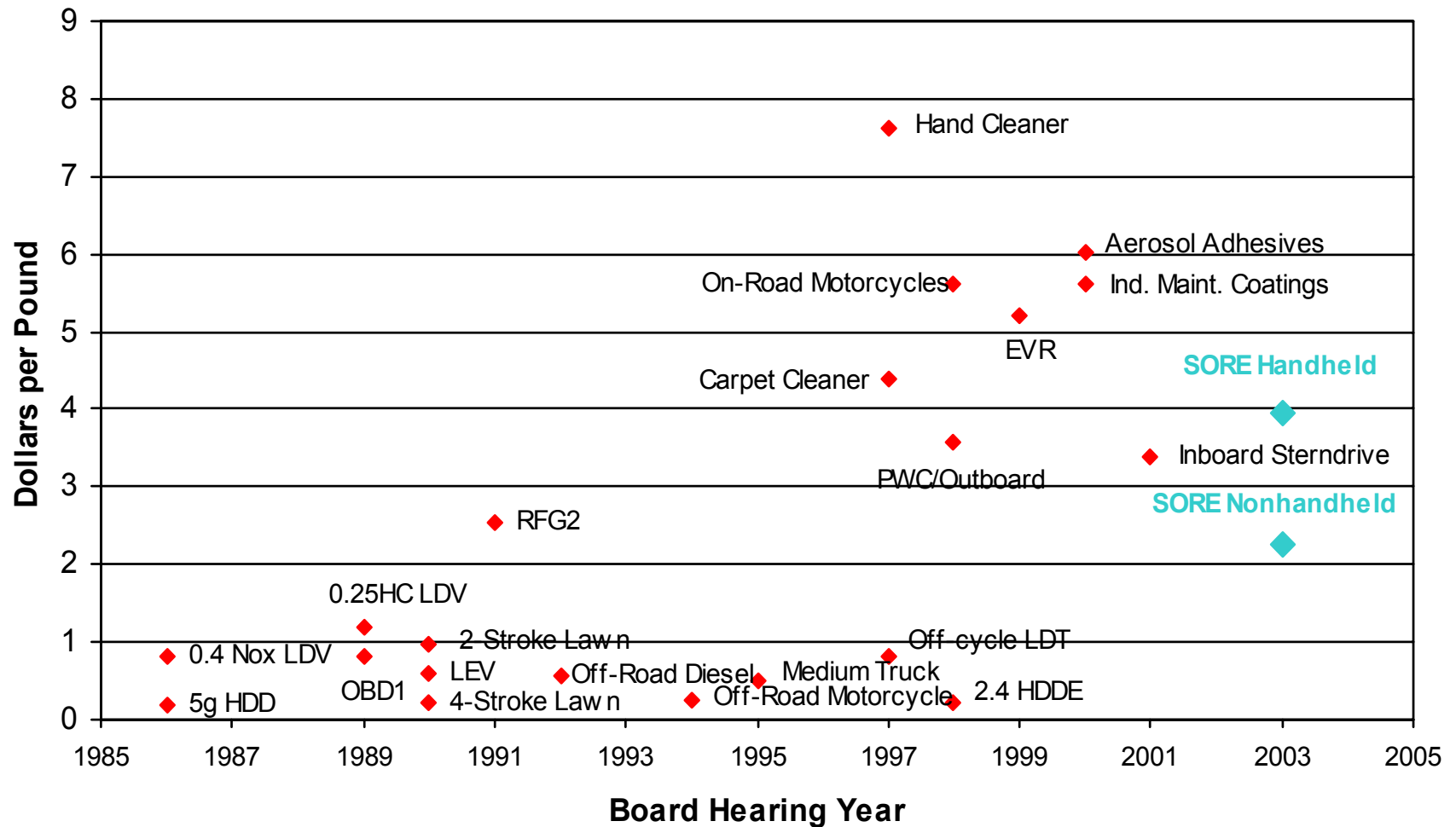


Estimated Retail Price Increase

- Handheld Equipment - \$2.16 to \$4.84
- Nonhandheld Equipment - \$37 to \$179

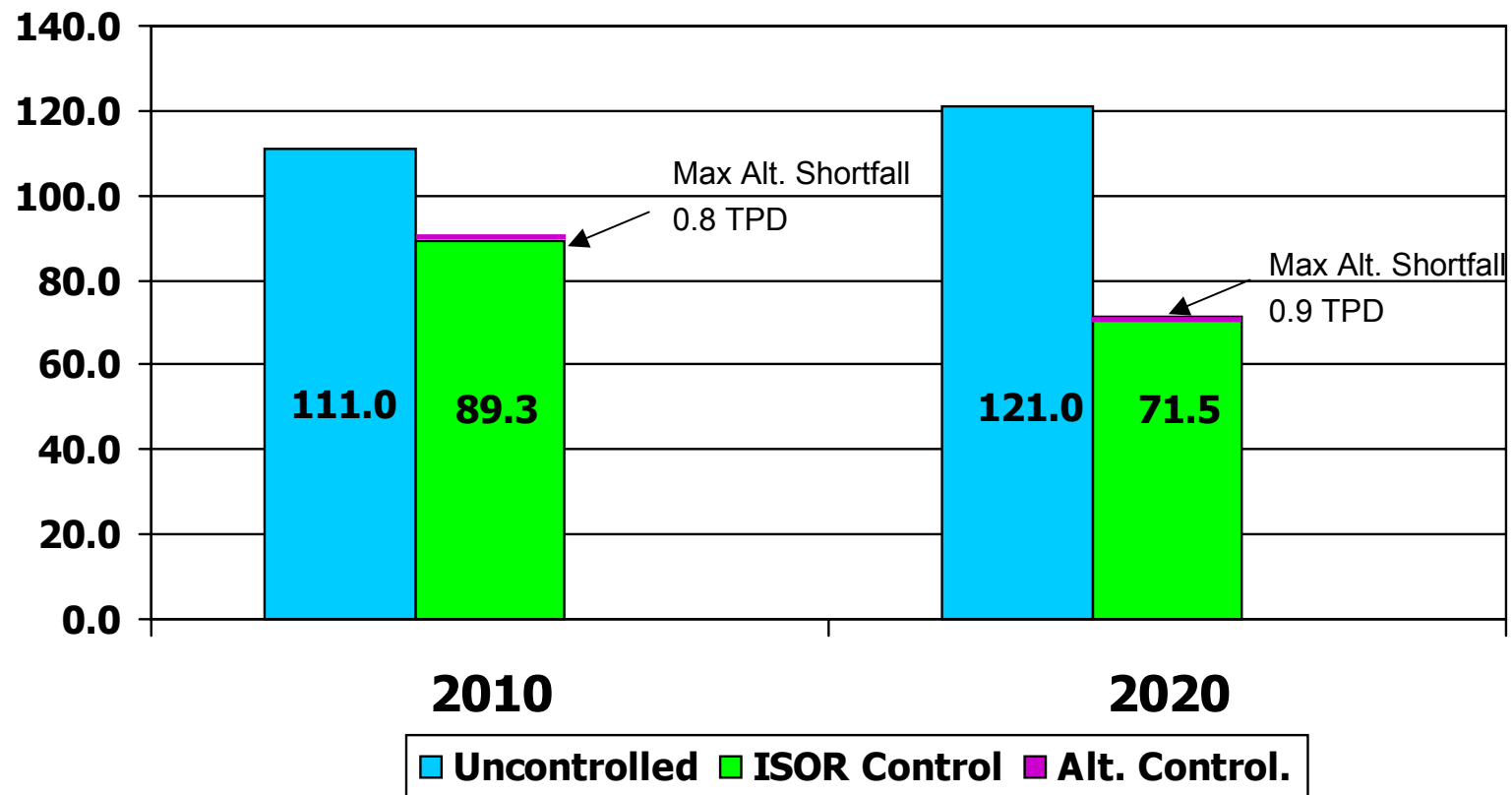


Cost Effectiveness of Major Regulations



Comparison of Controlled Emissions

(Annual Average Tons Per Day for Nonpreempt Equipment)



Conclusions

- Proposal and alternatives provide significant emission reductions
- Proposed controls are cost effective
- Standards are attainable with existing technologies
- Staff recommends Board adoption including alternatives

